Claims

What is claimed is:

1. A method of compensating for imbalance in a data storage disc stack within a data storage device during assembly of the data storage device, the disc stack having components including a drive motor having a stationary stator and a hub that rotates about a stationary spindle, the hub having a disc support flange supporting one or more data storage discs secured to the flange by a disc clamp, the method comprising acts of:

a) optically measuring one or more disc stack parameters, including disc stack component offsets for a most recent N disc stacks produced on an assembly line;

b) calculating a moving average of the most recent N disc stack component offsets;

c) utilizing the calculated averages to determine a desired component configuration type; and

d) feeding back the desired component configuration type to a component installation station to select the desired component configuration type for installation in a next disc stack.

2. The method of claim 1, further comprising acts of:

e) determining whether a next disc stack is to be assembled;

f) in response to a next disc stack to be assembled, receiving and installing the component configuration type to compensate for imbalance in the next disc stack;

g) optically measuring the disc stack parameters on the next disc stack; and

h) repeating acts b) through d).

3. The method of claim 2, further comprising repeating acts b) through h) for each subsequent disc stack.

4. The method of claim 1, wherein the disc stack parameters comprise N disc clamp offsets and N disc clamp offset angles wherein the disc clamp offset comprises a radial distance between an axial centerline of the drive motor and a center of the disc clamp and the disc clamp offset angle comprises a disc clamp offset direction measured from a zero reference mark on the disc clamp.

5. The method of claim 2, wherein receiving and installing the component configuration type comprises receiving, at a disc clamp installation station, a disc clamp configuration type to compensate for imbalance in the next disc stack and installing the disc clamp having the predetermined configuration type over the flange of the next disc stack to secure the at least one disc.

6. The method of claim 2, wherein optically measuring the disc stack parameters on the next disc stack comprises measuring the clamp offset of the next disc stack for use in a calculation of an average clamp offset for the most recent N disc stacks produced on the assembly line.

7. The method of claim 4, wherein the disc clamp is installed with a spring expansion ring designed to center the disc clamp with respect to the axial centerline of the drive motor and the disc stack parameters further comprise a most recent N ring offsets and a most recent N ring offset angles.

8. The method of claim 1, wherein the measured disc stack parameters further comprise:

a most recent N clamp offset angles;

a most recent N maximum ring outer diameters;

a most recent N drive motor center points; and

a most recent N clamp angles wherein the clamp angles comprise an orientation of a zero reference mark on the clamps.

9. The method of claim 1, wherein optically measuring the disc stack parameters is performed with an optical measurement system including the acts of capturing an image of the disc stack with a computer controlled digital camera, measuring the disc stack parameters, and transmitting the measured parameters to a computer.

10. The method of claim 1, further comprising calibrating an optical measurement system before optically measuring the most recent N disc stack parameters wherein the calibration procedure comprises:

capturing an image of a disc stack component installed on a disc stack;

referencing a zero mark on the disc stack component from which subsequent angle measurements are made clock wise;

calibrating the disc stack parameters that are measured in the most recent N disc stacks;

selecting and measuring a disc stack parameter multiple times to calibrate a pixel count of the computer controlled digital camera;

comparing one or more apparent measured values of the parameters to one or more actual measured values; and

utilizing a scaling factor to convert the apparent values to the actual values.

11. The method of claim 4, wherein utilizing the calculated averages to determine a desired component configuration type comprises:

determining whether the moving average of the component offset is greater than a predetermined threshold offset;

in response to the moving average for the component offset being less than or equal to the predetermined threshold offset, selecting an original component configuration type;

in response to the moving average of the component offset being greater than the predetermined threshold offset, determining whether the moving average of the component offset angle is within a first sector;

in response to the moving average of the component offset angle being within the first sector, selecting a component configuration type modified to compensate for offset angles located within the first sector.

in response to the moving average of the component offset angle being outside of the first sector, determining whether the moving average angle is within a second sector;

in response to the moving average angle of the component offset being within the second sector, selecting a component configuration type modified to compensate for offset angles located within the second sector;

in response to the moving average angle of the component offset being outside the second sector, determining whether the moving average angle is within a third sector;

in response to the moving average angle of the component offset being within the third sector, selecting a clamp configuration type modified to compensate for offset angles located within the third sector; and

in response to the moving average angle of the component offset being outside the third sector, utilizing a clamp configuration type modified to compensate for offset angles located within a fourth sector.

12. The method of claim 11, wherein a modified configuration type of the disc clamp comprises an addition or enlargement of one or more compensating cut off notches located at one or more angular locations on the disc clamp.

13 The method of claim 4, further comprising calculating a moving average of a most recent N disc stack clamp offset angle deltas, wherein a delta comprises the difference between the clamp offset angle of the next disc stack and the moving average of the offset angles for the most recent N disc stacks including the next disc stack.

14. The method of claim 13, wherein determining a clamp configuration type further comprises:

determining whether the moving average clamp offset angle delta is equal to or greater than a predetermined maximum delta for stability;

determining whether the moving average for clamp offset is greater than a predetermined maximum offset for stability; and

in response to the moving average clamp offset angle delta being equal to or greater than the predetermined maximum delta or the moving average for clamp offset being greater than the predetermined maximum offset, providing an indicator of equipment instability.

15. The method of claim 13, wherein the moving averages are calculated in correlation with a clamp install machine and a clamp supplier.

16. A system for providing an optimum disc stack component configuration to compensate for data storage disc stack imbalance during the assembly of a data storage device, the disc stack having components including a drive motor having a stationary stator and a hub that rotates about a stationary spindle, the hub having a disc support flange supporting one or more data storage discs secured to the flange by a disc clamp, the system comprising:

a digital camera capturing an image of the data storage disc stack, measuring one or more disc stack parameters for each disc stack of a sample size N, wherein the parameters

include a component offset comprising a component offset angle indicating the direction of the component offset, and transmitting the measured parameters to a processing unit;

the processing unit, in response to receiving the parameters, computing one or more dynamic averages of the disc stack parameters and from the dynamic averages determining an optimum disc stack component configuration type, wherein the dynamic averages include a dynamic average of the component offsets and a dynamic average of the component offset angles for a most recent N disc stacks measured, and the processing unit updating a memory unit and transmitting the optimum disc stack component configuration type for use during a component installation operation on a next disc stack; and

the memory unit storing the disc stack parameters, the dynamic averages, and the optimum disc stack component configuration type;

17. The system of claim 16, further comprising:

a bar code reader identifying the disc stack and one or more failure or process statistics associated with the disc stack;

a logic controller operating automated equipment to place each disc stack in position for an image to be captured; and

a display unit to display the optimum component configuration type and the disc stack parameters.

18. A method of providing an optimum disc clamp configuration type to compensate for disc stack imbalance in a data storage device, the disc stack having components including a drive motor having a stationary stator and a hub that rotates about a stationary spindle, the hub having a disc support flange supporting one or more data storage discs secured to the flange by a disc clamp, the method comprising:

measuring one or more data storage disc stack parameters in response to a disc stack reaching an optical measurement zone for a most recent N disc stacks, wherein the measured parameters are selected from the group consisting of a clamp offset, a clamp offset angle, a ring diameter; a ring offset, a ring offset angle, a motor center point, a ring concentricity with respect to the disc clamp and a clamp angle wherein the angles are measured from a zero reference mark on the clamp, and the clamp is used to balance the disc stack;

utilizing the measured disc stack parameters to compute one or more averages; wherein the averages include dynamic moving averages of the clamp offset and the clamp offset angle for a most recent N measured disc stacks; and

from the dynamic moving averages, determining an optimum disc clamp configuration type for a subsequent disc stack.

19. The method of claim 18, wherein a modified configuration type of the data storage disc clamp includes an addition or enlargement of one or more compensating cut off notches located at one or more angular locations in the perimeter of the data storage disc clamp and wherein determining the proper clamp configuration type comprises:

determining whether the dynamic moving average of the clamp offset is greater than a predetermined threshold offset wherein the predetermined threshold offset is of a nominal value;

in response to the dynamic moving average for clamp offset being less than or equal to the predetermined threshold offset, providing an original clamp configuration;

in response to the dynamic moving average of the clamp offset being greater than the threshold offset, determining whether the dynamic moving average of the clamp offset angle is within a first quadrant, wherein the first quadrant includes one or more angles from -45 to 45 degrees of a zero reference marking;

in response to the dynamic moving average of the clamp offset angle being within the first quadrant, providing a clamp configuration type modified to compensate for clamp offset angles within the first quadrant;

in response to the dynamic moving average of the clamp offset angle being outside of the first quadrant, determining whether the dynamic moving average of the clamp offset angle is within a second quadrant, wherein the second quadrant includes one or more angles greater than 45 degrees and less than 135 degrees;

in response to the dynamic moving average of the clamp offset angle being within the second quadrant, providing a clamp configuration type modified to compensate for clamp offset angles within the second quadrant;

in response to the dynamic moving average of the clamp offset angle being outside the second quadrant, determining whether the dynamic moving average of the clamp offset angle is within a third quadrant, wherein the third quadrant includes one or more angles from 135 degrees to 225 degrees;

in response to the dynamic moving average of the clamp offset angle being within the third quadrant, providing a clamp configuration type modified to compensate for clamp offset angles within the third quadrant; and

in response to the dynamic moving average of the clamp offset angle being outside the third quadrant, providing a clamp configuration type modified to compensate for clamp offset angles within a fourth quadrant wherein the fourth quadrant includes one or more angles greater than 225 degrees and less than 315 degrees.

20. A controller for a data storage device assembly line comprising:

a microprocessor; and

an optical measurement means for providing an optimum disc stack component configuration type that compensates for imbalance in a data storage disc stack during assembly of the data storage device.